REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Official Action dated February 10, 2006. In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

Claims 1, 3-8, 10-16, and 18-32 are under consideration in this application. Claims 1 and 21 are being amended, as set forth above, in order to more particularly define and distinctly claim Applicants' invention.

The claims are being amended to correct formal errors and/or to better disclose or describe the features of the present invention as claimed. Applicants hereby submit that no new matter is being introduced into the application through the submission of this response.

Prior Art Rejections

Claims 1, 3, 16, 18-19, 21-22 and 31-32 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Pat. No. 6,461,909 to Marsh et al. (hereinafter "Marsh"), and claims 4-8, 10-15, 20 and 23-30 were rejected under 35 U.S.C. § 103(a) as being unpatenable over Marsh in further view of U.S. Pat. App. Pub. No. 2001/0006838 of Won (hereinafter "Won") and U.S. Pat. No. 6,617,248 to Yang (hereinafter "Yang"). These rejections have been carefully considered, but are most respectfully traversed.

The fabricating method of a semiconductor integrated circuit device of the invention, as now recited in claim 1, comprises forming a bottom electrode (p. 19, line 7) of a capacitor with high-k material on a semiconductor substrate by a chemical vapor deposition method in a sub-atmospheric pressure using an organoruthenium compound as a precursor, which includes the steps of: (a) providing the semiconductor substrate in a deposition chamber; (b) after the step (a), increasing a temperature of the semiconductor substrate in the chamber up to a desired temperature without supplying any oxidation gas to the deposition chamber; (c) after the step (b), separately supplying the precursor and an oxidation gas into the deposition chamber to form a ruthenium film for the bottom electrode with a desired thickness on the heated semiconductor substrate, said oxidation gas being separately supplied to said

deposition chamber by a supplying system different from a precursor supplying system and only during when the precursor being supplied ("*The forgoing process is characterized in that the supply of an oxygen gas is limited to when the precursor is supplying during formation of a bottom electrode of ruthenium*" p. 21, lines 18-20); (d) after the step (c), stopping the supply of the precursor and said oxidation gas; and (e) after the step (d),decreasing the temperature of the semiconductor substrate without supplying any oxidation gas to the deposition chamber. (page 18, lines 23-24). The bottom electrode essentially consists of ruthenium ("a *bottom electrode of ruthenium i.e., the deposition period*" p. 19, line 7; "*the reaction of the gases and the oxygen for Ru disposition*" p. 20, lines 5-6). The underlined features allow forming a bottom electrode of ruthenium with a lesser amount of oxygen contamination than the detection limit of a TDS method such that it will not oxidize a barrier film (p. 19, lines 21-23).

The invention is also directed to fabricating method of a semiconductor integrated circuit device comprising forming a top electrode essentially consisting of ruthenium ("*a top electrode of ruthenium*" p. 22, line 15) of a capacitor of the invention, as now recited in claim 21, which is similar to claim 1, except that the oxidation gas is additionally supplied to said deposition chamber during when the substrate temperature is increased, and when the substrate temperature is decreased. The underlined features allow forming a top electrode of ruthenium by inhibiting an increase in the leakage current due to the reduction of a high-k dielectric film of a capacitor (p. 22, lines 18-21).

In particular, features of claim 1 include that (1) increasing the temperature of the semiconductor substrate without supplying any oxidation gas to the deposition chamber before forming the bottom electrode of ruthenium and (2) decreasing the temperature of the semiconductor substrate without supplying any oxidation gas to the deposition chamber after forming the bottom electrode of ruthenium. Features of claim 21 include that (3) increasing the temperature of the semiconductor substrate with supplying an oxidation gas to the deposition chamber before forming the top electrode of ruthenium and (4) decreasing the temperature of the semiconductor substrate with supplying an oxidation gas to the deposition chamber after forming the top electrode of the ruthenium film.

Applicants respectfully contend that neither Marsh, Won, nor Yang, or their combination as relied upon by the Examiner, teaches or suggests the features of Claim 1: supplying an oxidation gas separately from the supply of the precursor into a deposition chamber and **only during** the precursor-supplying step for forming a bottom electrode (p. 22,

line 15) essentially consisting of ruthenium of a capacitor; or Claim 21: supplying an oxidation gas separately from the supply of the precursor into the deposition chamber and also **during** the substrate temperature increasing and decreasing steps and the precursor-supplying step for forming a top electrode essentially consisting of ruthenium of a capacitor.

In contrast, Marsh ***deliberately*** (1) forms a Ru layer 28 in Fig. 2 first, (2) converts the Ru layer 28 into a RuSixOy layer 29 in Fig. 3 (col. 8, lines 9-14, 32-33), and then (3) forms a conductive layer 31 (maybe Ru) on top of the RuSixOy layer 29 in Fig. 4 (col. 8, lines 20-22). In the embodiment in Fig. 5, additional conductive layers 42-44 are formed before forming the conductive layer 31. In short, Marsh's method uses multiple steps to provide multiple layers, which is much more time-consuming and complicated than the straight-forward method of the present invention: forming one and only one electrode layer of a capacitor essentially consisting of ruthenium.

Although there may be some oxygen contamination at the interface between the substrate and the Ru electrode of the invention, the formation of the oxygen contamination is ***accidentally***, rather than ***deliberately*** as in Marsh. In particular, the invention inhibits the oxygen contamination to be lower than the detection limit of a TDS method such that it will not oxidize a barrier film (p. 19, lines 21-23), rather than intentionally growing the RuSixOy layer 29 as in Marsh ("*form the RuSixOy-containing adhesion layer 29*" col. 7, lines 64-67). Marsh forms at least one RuSixOy containing adhesion layer in a stack 34 (col. 8, lines 47-52) *as a barrier* to enhance the oxidation-resistance properties of the stack 34 (col. 9, lines 34-36), while the invention *directly inhibits* any O elements oxidized onto the surface of the metal (Ru) electrode *without building a barrier*. Specifically, Marsh purposefully produces a metal **oxide** (RuSixOy) layer, i.e., **promoting** the O content therein to provide "*sufficient adhesion properties which were attained with the amount of Ru converted* (col. 8, lines 39-40)", while the invention directly **reduces** the possibility for O elements oxidized onto the surface of the metal (Ru) electrode. It is well established that a rejection based on cited references having contradictory principles or principles that teach away from the invention is improper.

Contrary to the Examiner's assertion (p. 3, 2nd paragraph of the outstanding Office Action) that the cited description in Marsh on col. 7, line 50 to col. 8, line 61 described the time periods for supplying and stopping oxidizing gas to the reaction chamber for forming the electrodes, Marsh only generally discloses keeping the deposition temperature at 100-700 °C (preferably 200-500°C) when the RuSixOy adhesion layer is deposited (col. 7, lines 50-60).

Marsh simply does NOT specify the particular time periods for supplying or stopping the oxidizing gas to the reaction chamber for forming the electrodes, especially in the periods of while heating up the wafer to deposition temperature and while cooling down the wafer from deposition temperature.

Although the invention provide a Ru electrode on a substrate as disclosed in Marsh, the invention applies the specific time periods for supplying or stopping the oxidizing gas to the reaction chamber for forming the electrodes in conjunction with heating up and cooling off the wafer to achieve unexpected results or properties, for example, to form a bottom electrode of ruthenium with a lesser amount of oxygen contamination than the detection limit of a TDS method such that it will not oxidize a barrier film to form a top electrode of ruthenium by inhibiting an increase in the leakage current due to the reduction of a high-k dielectric film of a capacitor. The presence of these unexpected properties is evidence of nonobviousness. MPEP§716.02(a).

> "*Presence of a property not possessed by the prior art is evidence of nonobviousness. In re Papesch, 315 F.2d 381, 137 USPQ 43 (CCPA 1963) (rejection of claims to compound structurally similar to the prior art compound was reversed because claimed compound unexpectedly possessed anti-inflammatory properties not possessed by the prior art compound); Ex parte Thumm, 132 USPQ 66 (Bd. App. 1961) (Appellant showed that the claimed range of ethylene diamine was effective for the purpose of producing " 'regenerated cellulose consisting substantially entirely of skin' " whereas the prior art warned "this compound has 'practically no effect.' ").*

Although "[t]*he submission of evidence that a new product possesses unexpected properties does not necessarily require a conclusion that the claimed invention is nonobvious. In re Payne, 606 F.2d 303, 203 USPQ 245 (CCPA 1979). See the discussion of latent properties and additional advantages in <u>MPEP § 2145</u>,*" the unexpected properties were <u>unknown and non-inherent functions</u> in view of Marsh, since Marsh does not inherently achieve the same results. In other words, these advantages would not flow naturally from following the teachings of Marsh, since Marsh fails to suggest the particular time periods (with respect to heating up and cooling off the wafer) for supplying and stopping oxidizing gas to the reaction chamber for forming the electrodes.

Applicants further contend that the mere fact that one of skill in the art could rearrange Marsh to meet the terms of the claims is not by itself sufficient to support a finding

of obviousness. The prior art must provide a motivation or reason for one skilled in the art to provide the unexpected properties, such as forming a bottom electrode of ruthenium with a lesser amount of oxygen contamination than the detection limit of a TDS method or forming a top electrode of ruthenium by inhibiting an increase in the leakage current due to the reduction of a high-k dielectric film of a capacitor, without the benefit of appellant's specification, to make the necessary changes in the reference device. *Ex parte Chicago Rawhide Mfg. Co.*, 223 USPQ 351, 353 (Bd. Pat. App. & Inter. 1984). MPEP§2144.04 VI C.

Won and Yang fail to compensate for Marsh's deficiencies. Won discloses some organoruthenium compound. However, Won does not teach or suggest the particular time periods (with respect to heating up and cooling off the wafer) for supplying and stopping oxidizing gas to the reaction chamber for forming the electrodes of the invention.

Yang only discloses annealing, but not the above-mentioned particular time periods (with respect to heating up and cooling off the wafer) for supplying and stopping oxidizing gas to the reaction chamber for forming the electrodes. In addition, Yang shares the same deficiency by internationally forming a RuO2 film (rather than a Ru film).

Applicants contend that neither cited prior art reference, nor their combination teaches or suggests each and every feature of the present invention as disclosed in independent claims 1 and 21. As such, the present invention as now claimed is distinguishable and thereby allowable over the rejections raised in the Office Action. The withdrawal of the outstanding prior art rejections is in order, and is respectfully solicited.

Conclusion

In view of all the above, clear and distinct differences as discussed exist between the present invention as now claimed and the prior art reference upon which the rejections in the Office Action rely, Applicants respectfully contend that the prior art references cannot anticipate the present invention or render the present invention obvious. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance

of the above-captioned application, the Examiner is invited to contact the Applicants' undersigned representative at the address and telephone number indicated below.

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